



CONTRIBUTIONS FROM THE ILLINOIS BASIN – DECATUR PROJECT

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CSLF – WARSAW POLAND
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*Safe and Effective storage:
The pieces Have come together*



Barriers (2003)



Obstacles (2009)



Challenges (2011)



Successes (2015)



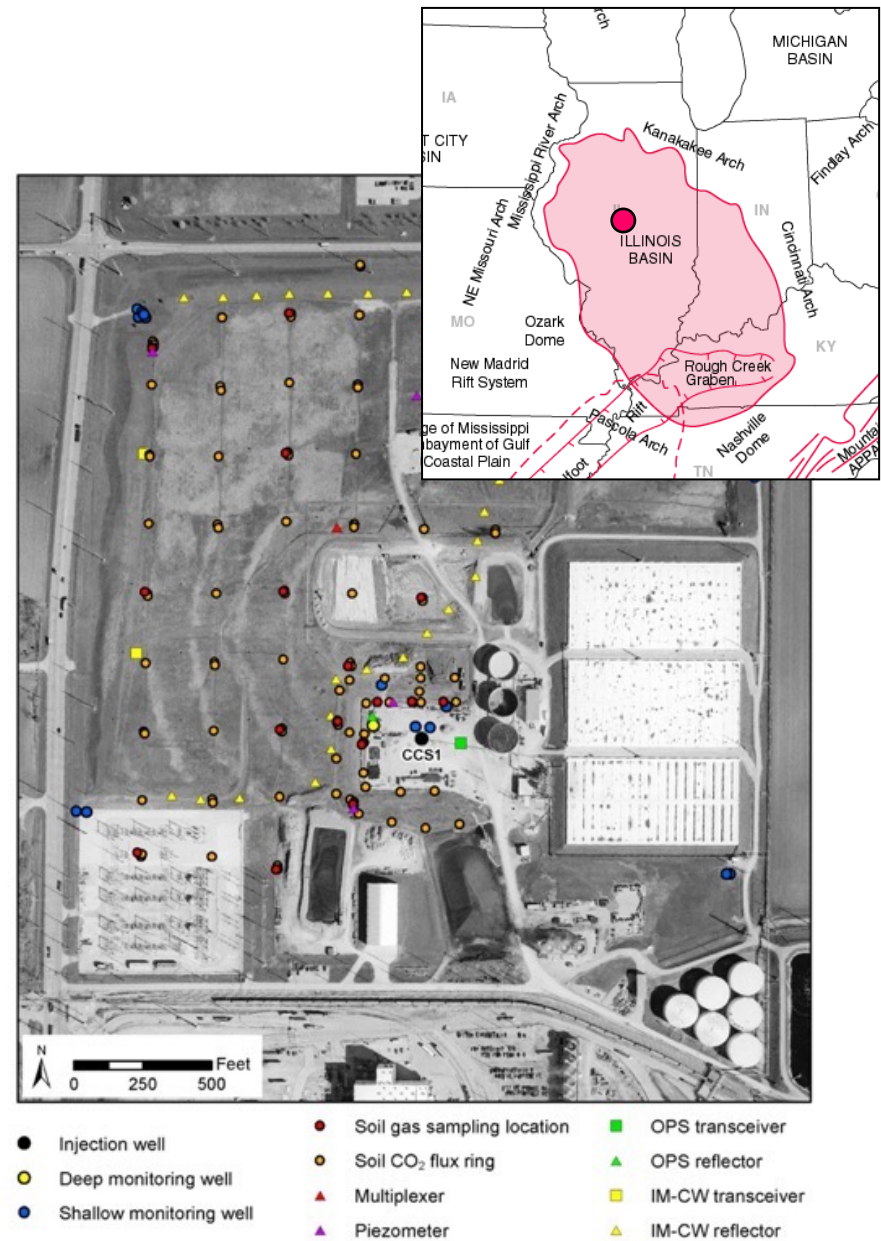
Deployment (2017)



Community Impacts
(2021)

Illinois Basin – Decatur Project

- Captured, transported, stored, and monitored 1 million tonnes of CO₂ from biofuel production in an onshore Saline Reservoir
- First-of-a-kind monitoring, verification, and accounting program
- Proved storage potential, injectivity, and containment
- Met and exceeded all technical and non-technical challenges
- Successful Class VI permitting
- Conducted microseismic monitoring and interpretation
- Laid foundations for multiple projects
- Build international, national, and regional capacity
- Stakeholder engagement strategy built trusted relationships
- Created comprehensive data set



IBDP by the numbers (IBDP + ICCS):

- 2.5 million stored from **biofuels**
- More than **5,000 meters** of drilled wells
- More than **245 meters** of collected core
- Near-surface groundwater monitoring efforts have resulted in more than **50,000 analyses**
- Basin-scale modeling used **1,020,000 CPU-hours** of XSEDE supercomputing resources.
- More than **1,000 visitors** from **29 countries** have been to IBDP and ICCS
- More than **100 people** from at least **10 organizations** have worked together to make these projects a success





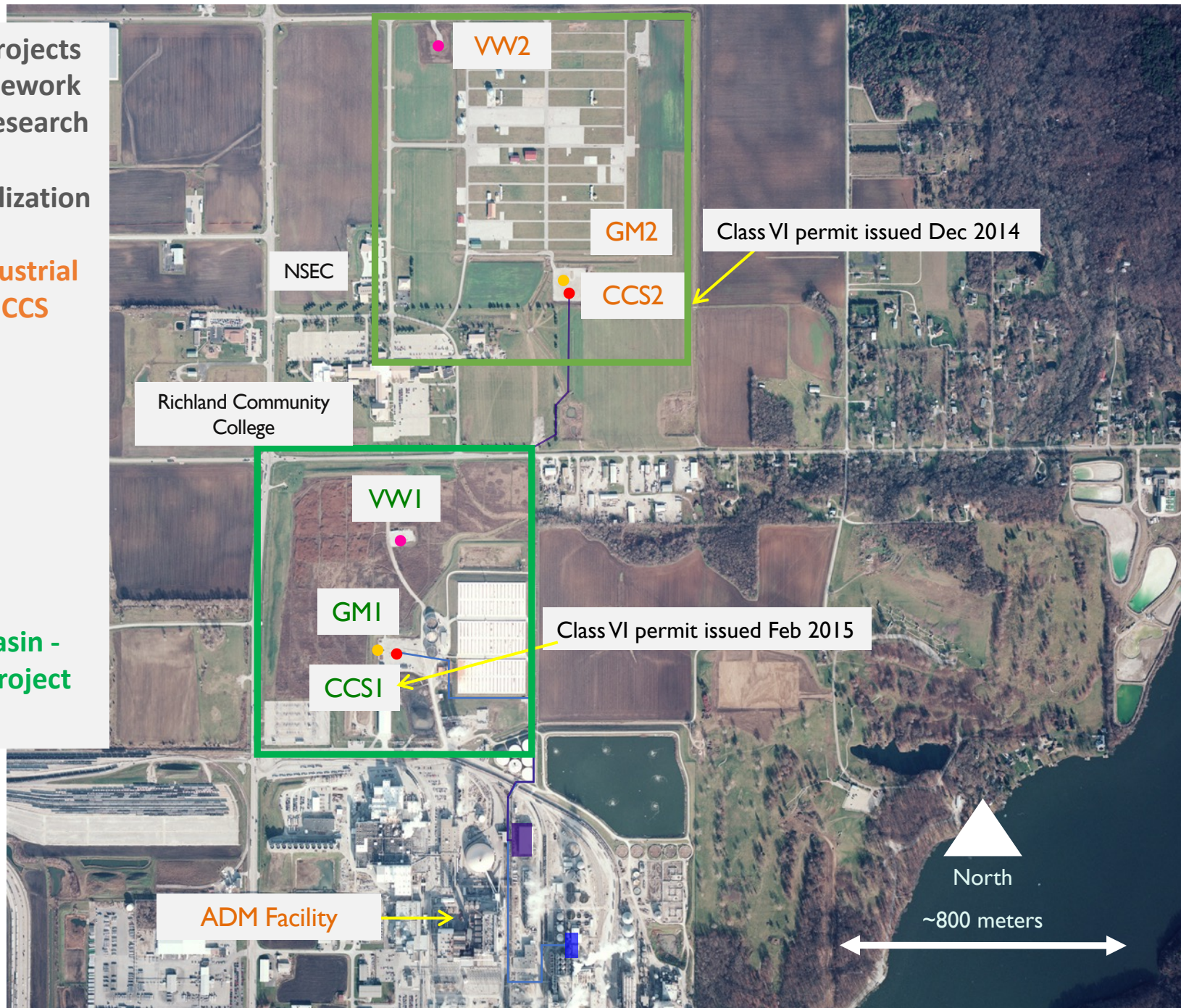
Key Learnings from Illinois Experience

- Storage of carbon dioxide is safe, viable, and important for climate mitigation strategies
- Geology is critical and will always remain key factor
- Baseline environmental assessments are critical
- Simplicity is key success factor
- Regulatory framework is in place to ensure safe storage
- Scientific and engineering require alignment with policy
- Pilot and demonstration projects provide critical insights

Multiple Projects
Build Framework
for CCUS Research
and
Commercialization

Illinois Industrial
Sources CCS

Illinois Basin -
Decatur Project



IL-ICCS

Industrial scale
Risk based

IBDP

Demonstration scale
Research based



0.5 miles
800 meters

Monitoring Summary

- Injection wells (2)
- Verification wells (2)
- Geophysical wells (2)
- Compliance wells (4)
- Research wells (24)
- Soil gas points (35)
- Soil flux points (145)
- Eddy covariance station (1)
- Continuous GPS station (1)
- InSAR artificial reflectors (21)

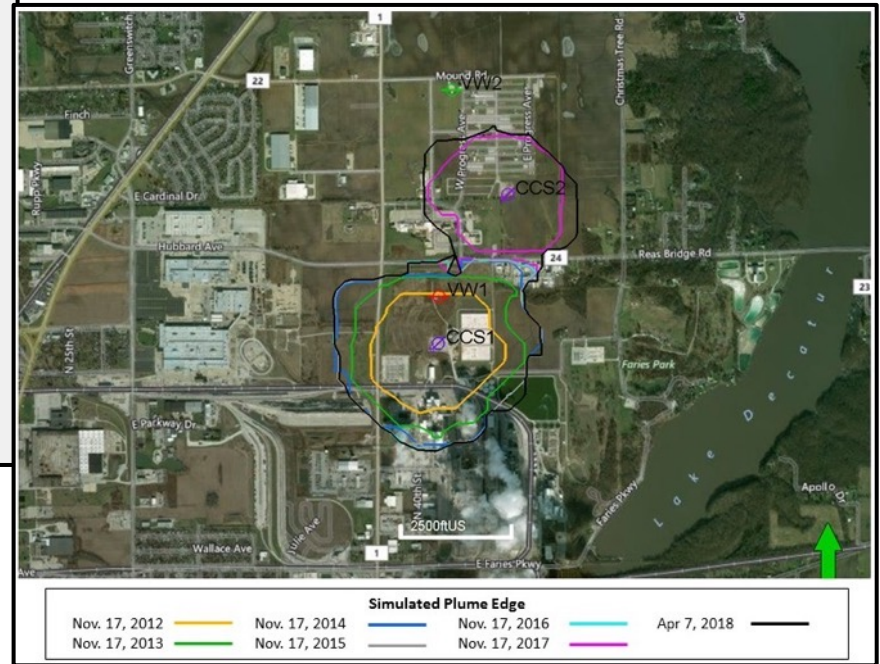
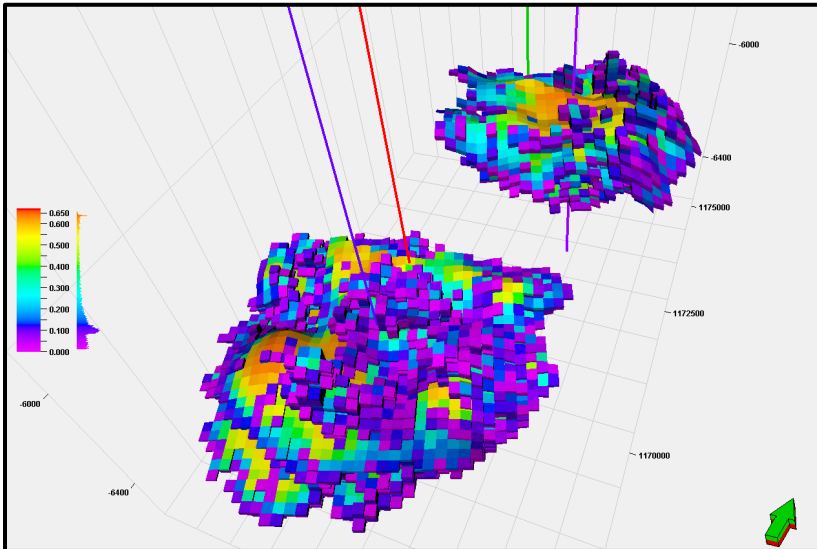


IBDP Monitoring Summary

	Monitoring Activity	Freq.	Pre-injection			Injection				Post-Injection					
			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Surface	Aerial imagery	SA		x	x	x	x	x	x	x	x	x	x	x	x
	Eddy covariance	C					x	x	x						
	Soil flux - network *	W-Q		x	x	x	x	x	x	x					
	Soil flux - multiplexer	C			x	x	x	x	x	x					
	Tunable diode laser- single path	C					x	x							
	Tunable diode laser- multi path *	C								x					
	InSAR *	BW				x	x								
	Continuous GPS *	C					x	x	x						
Near-Surface	Soil gas sampling	Q-A				x	x	x	x	x	x				
	Shallow groundwater sampling	M-Q-SA		x	x	x	x	x	x	x	x	x	x	x	x→
	Shallow electrical earth resistivity *	A	x	x	x										
Subsurface	Pressure/temp. - VW1 and CCS1	C				x	x	x	x	x	x	x	x	x	x→
	Pulsed neutron (CCS1, VW1, GM1)	Q-A		x		x	x	x	x	x			x		x→
	Deep fluid sampling (VW1)	SA				x	x	x	x	x		x	x	x	
	Passive seismic monitoring (GM1)	C			x	x	x	x	x	x	x	x	x	x	x→
	Seismic/3D VSP imaging	SA-A			x	x	x	x	x	x					x→
	Mechanical integrity (CCS1, VW1)	A			x	x	x	x	x	x					x

Abbreviations: C = Continuous, W = Weekly, BW = Biweekly, M = Monthly, Q = Quarterly, SA = Semi-Annually, A = Annually,
 x = planned, not permit required; * = experimental technique or deployment; x = planned, permit required;
 x→ = permit activity required beyond 2020; yellow box highlights decrease in monitoring activity during PISC phase

Plume Distribution of IBDP and ICCS

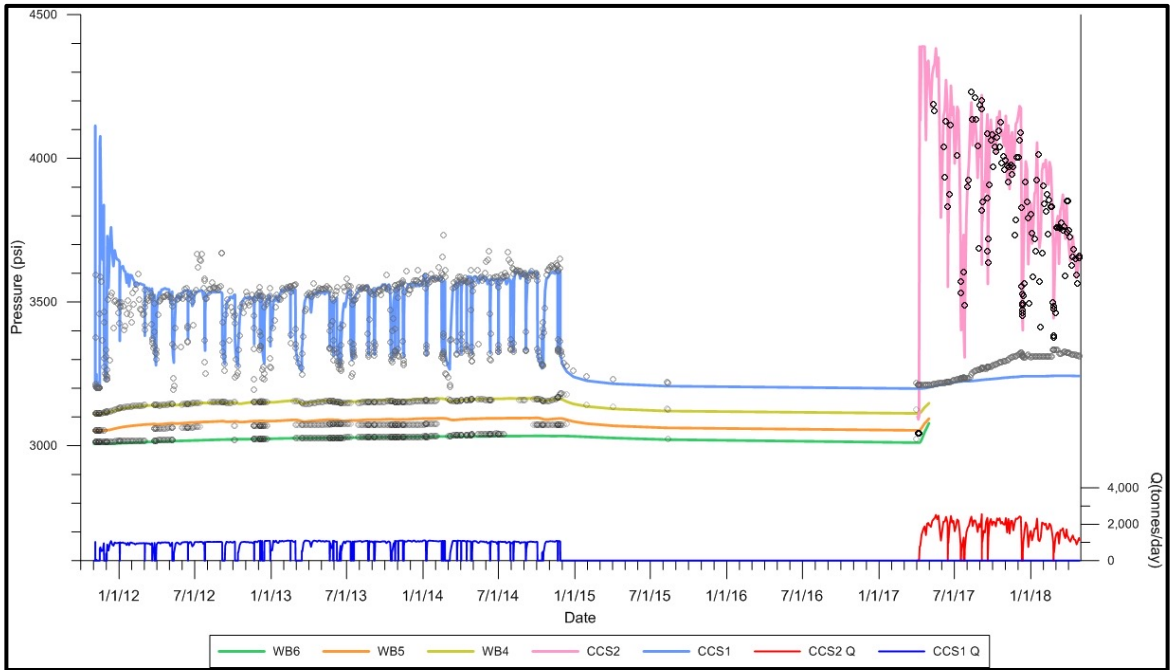
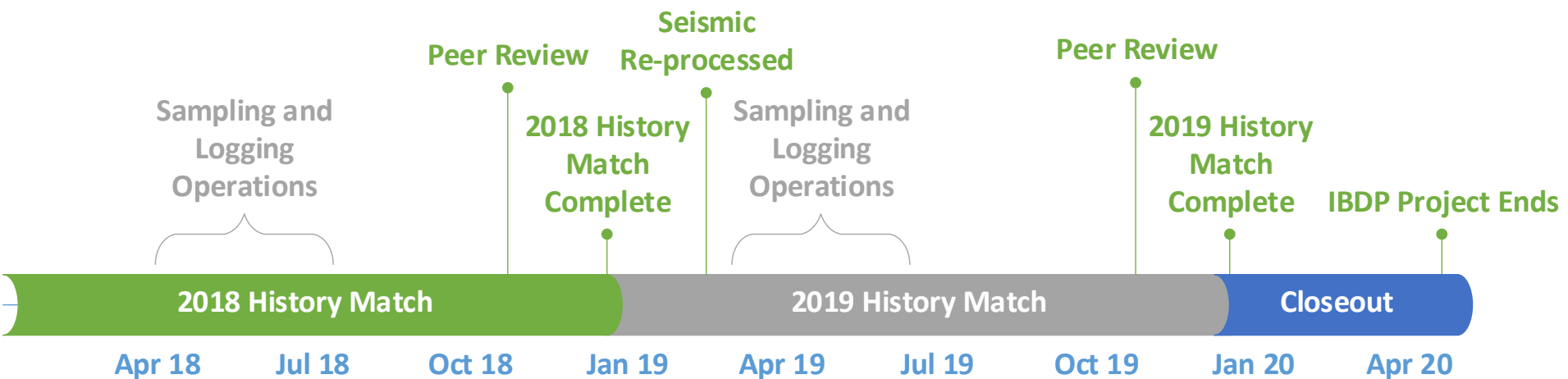


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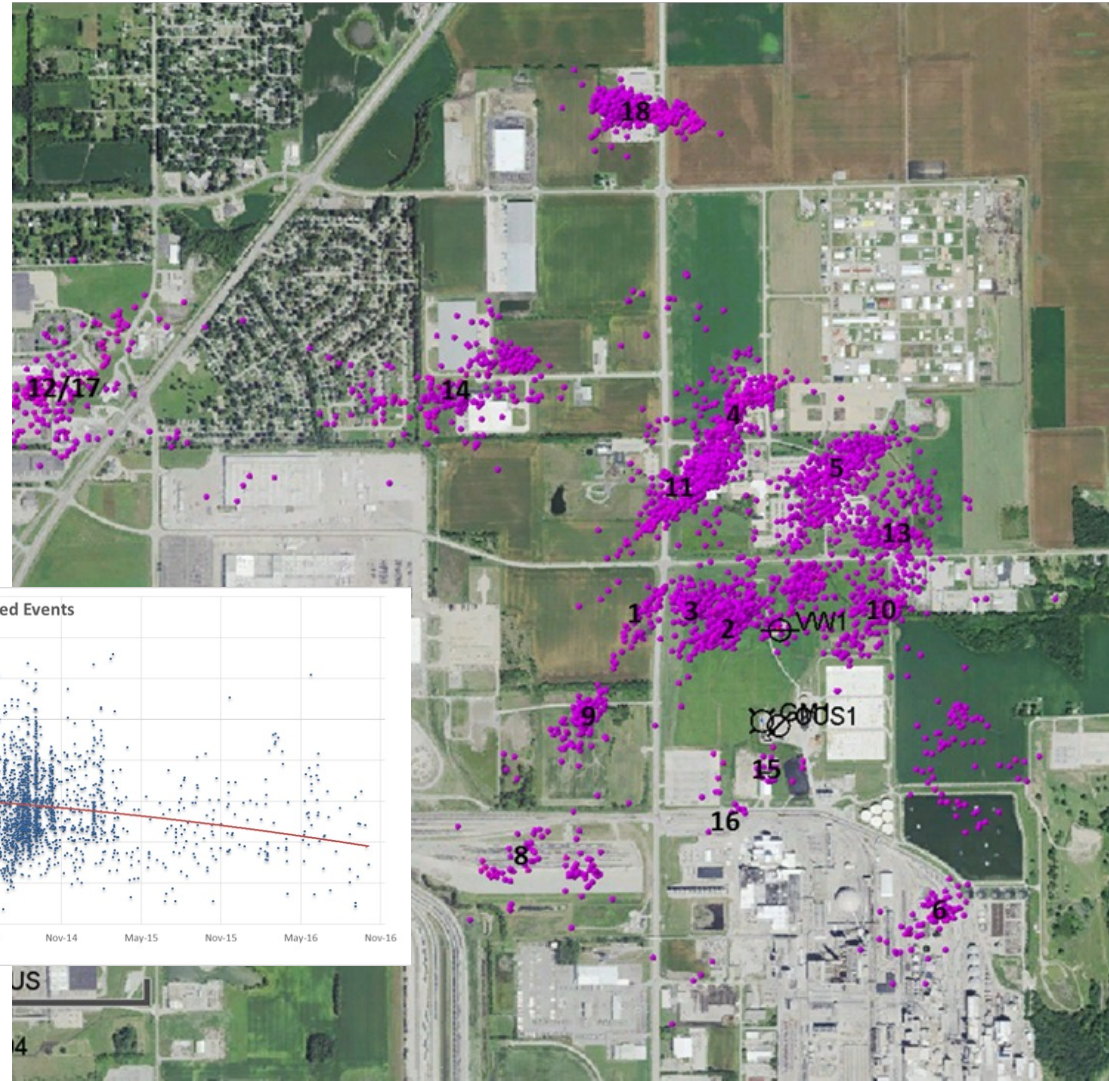
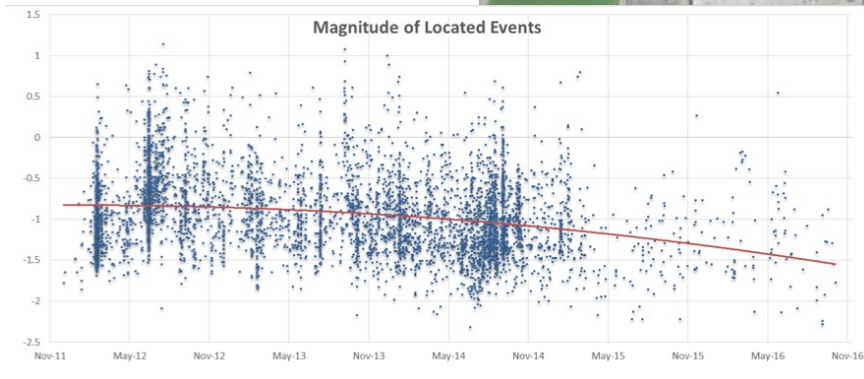
3D simulated CO₂ plume distribution on Apr. 7, 2018. Vertical exaggeration is 5x.

Modeling and History Matching



Passive Seismic (Microseismic) Monitoring

- Location critical to understanding reservoir response
- Relation of clusters to *pressure front* and *basement characteristics*
- 5 surface seismometers also used

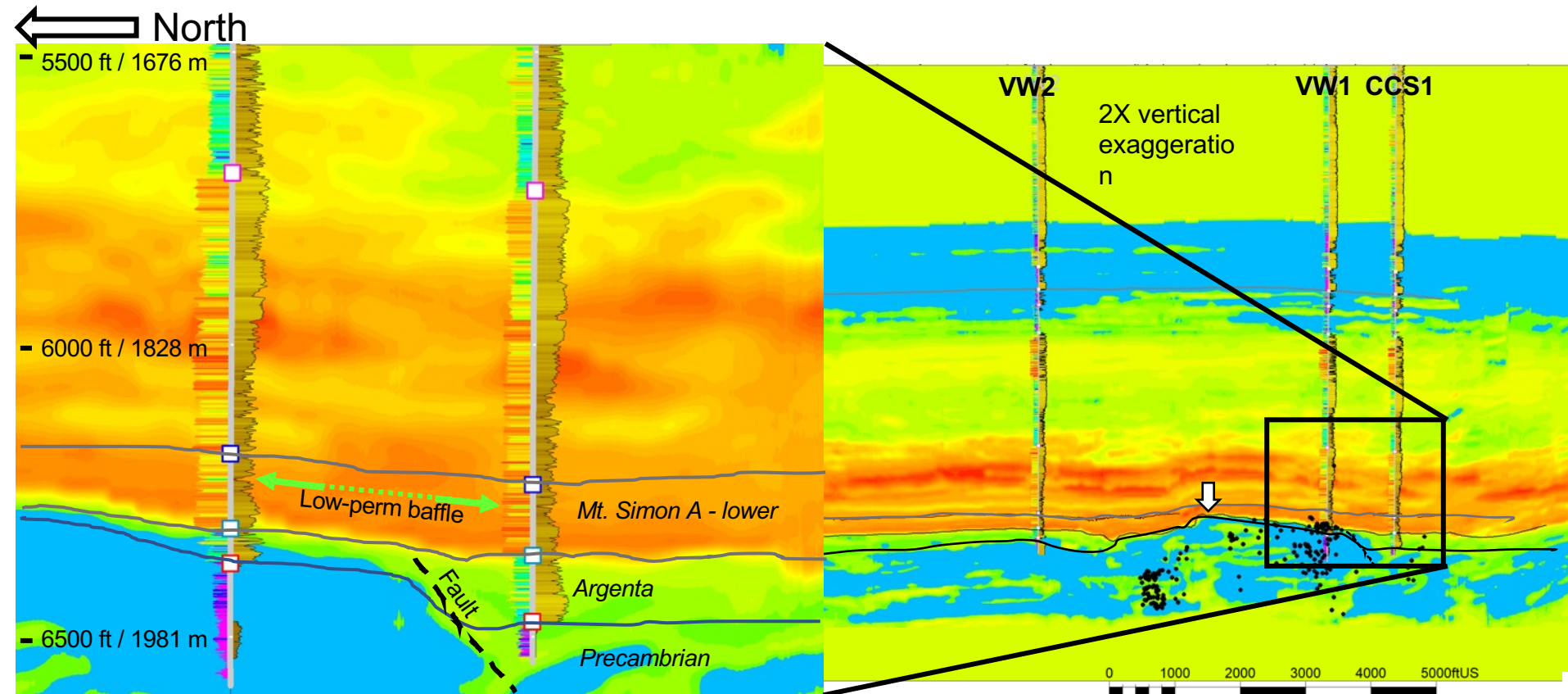


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Reflection Seismic Porosity Inversion

Wells and seismic events projected onto the cross section from up to 200 ft.

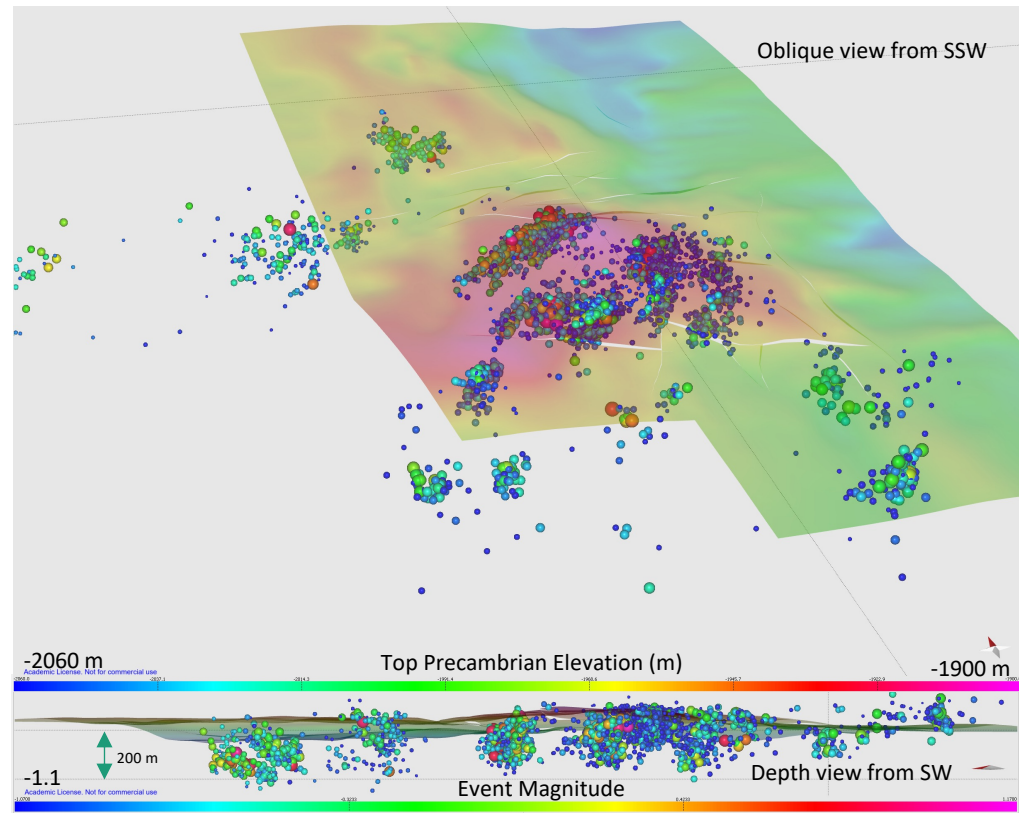


Response of Precambrian Basement

More than 90% of the induced seismicity occurs in the basement below the reservoir.

The below the reservoir response shows:

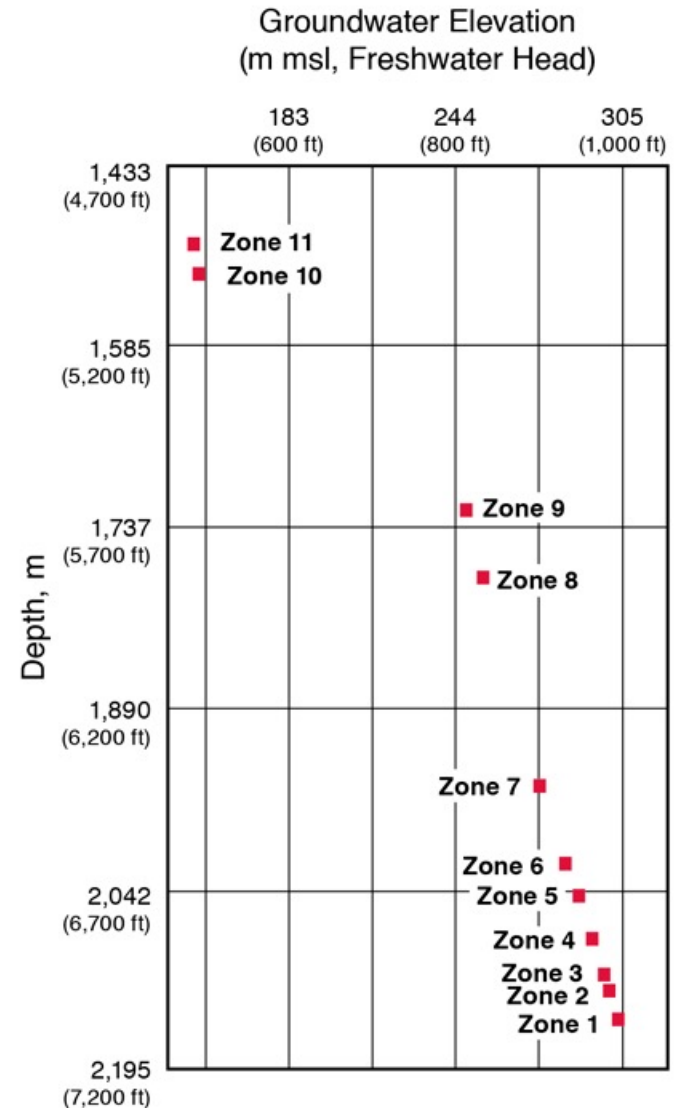
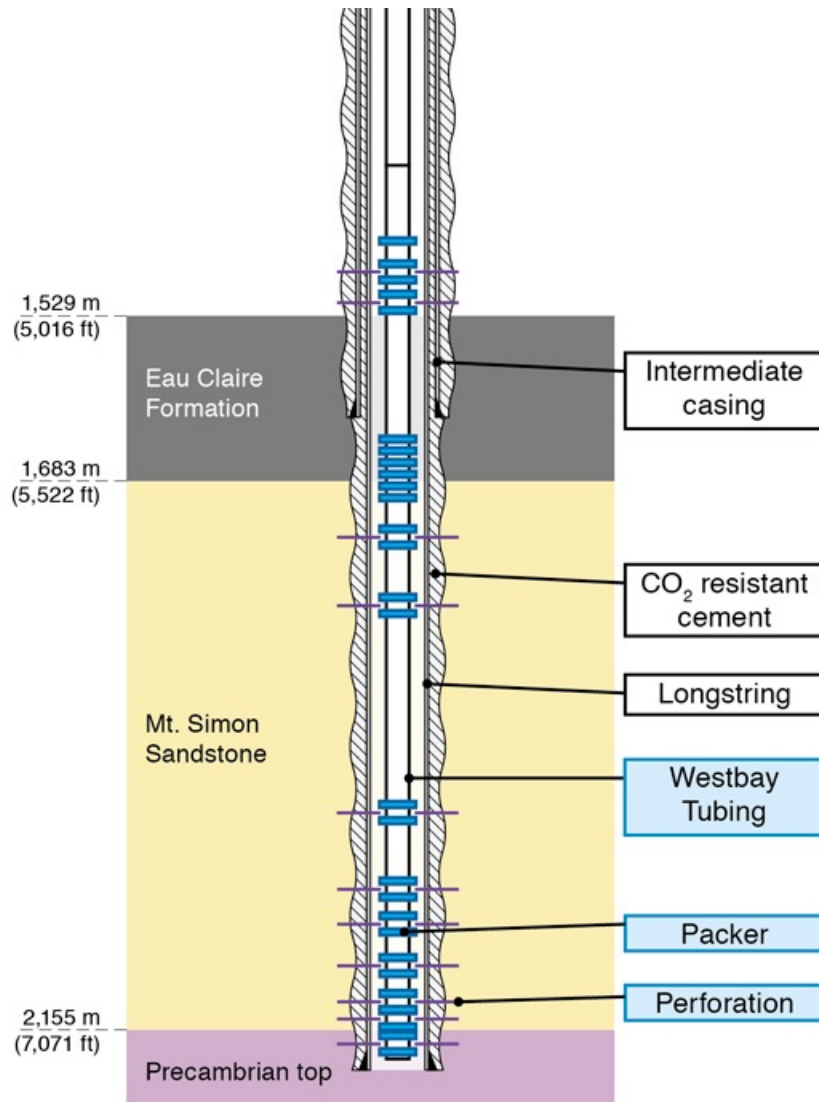
- Significant induced microseismicity during CCS1 injection
- Seismic activity diminished to low level after injection stopped
- Seismic activity has not increased during CCS2 injection
- Fluid/pressure pathway to basement likely includes faults



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VW1 Westbay Completion



Recompletion of VW1 Monitoring Well

Westbay System

Flexible, industry-tested design offers Superior Performance

OVERVIEW
The Westbay System is a completely variable, multilevel monitoring technology that allows testing of hydraulic conductivity, monitoring of fluid pressure and collection of fluid samples from multiple zones within a single borehole. Designed for reliability and defensibility, the Westbay System can accommodate a wide variety of borehole conditions including diameter, depth, temperature and chemistry considerations.

Westbay System advantages:

- obtain measurements and samples at any number of discrete locations along a single borehole
- collect samples without purging
- designed for long-term monitoring
- engineered to operate at great depths
- reduced drilling and installation costs, with minimal site disturbance
- removable probes allow for convenient calibration and servicing
- built-in defensible QA/QC procedures

WESTBAY SYSTEM PRODES
A variety of probes are available for use with the Westbay System. Reliable, accurate, portable wireline-operated probes can be lowered into the casing system and used to:

- packers in open borehole
- packers through temporary casing
- packers in a cased well
- direct backfill

COMPLETION METHODS INCLUDE

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SAMPLING PRODES
Westbay Systems offer the unique ability to collect discrete fluid samples at formation pressures. For sample collection the probe and sample container are lowered to the desired depth, where the sample is collected into the container. The probe and container are then retrieved to the surface for further analysis.

Westbay System sampling allows you to:

- collect samples with minimal disturbance and without repeated purging
- maintain samples at formation pressure
- monitor pressure during sampling
- document quality assurance

WESTBAY SYSTEM ADVANTAGES

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WELL COMPLECTIONS
Westbay Systems are engineered with a unique, customisable casing system. The casing system is available in two sizes (MP28 and MP36) and manufactured from plastic or stainless steel to fit various borehole dimensions and operational requirements. Hydraulically-inflated packers and/or backfill provide engineered seals between monitoring zones, preventing unwanted flow and cross-contamination. Valved parts in the zones provide access for monitoring, sampling and hydraulic testing.

1 PACKERS

- Engineered seal in a range of borehole sizes
- No dedicated inflation lines
- Controlled hydraulic inflation with record of pressure and volume
- Quality control tests to confirm performance at any time after installation

2 MEASUREMENT PORT

- For fluid pressure measurements, fluid sampling and low-k testing

3 PUMPING PORT

- For purging, hydraulic conductivity testing, and quality control testing

For more information, visit www.bakerhughes.com

Advancing Reservoir Performance

REPACKER™ Reactive Element Packers



HCM-Plus Hydraulic Sliding Sleeve

Baker Hughes intelligent well systems flow control valves

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The Baker Hughes Inforce HCM™-Plus downhole valve provides remote and reliable isolation of a specific interval. It reduces costs and minimizes production downtime by allowing production or injection from the wellbore to be altered without intervention from the surface. This product is compatible with oil- or water-based control fluids.

The hydraulically balanced piston yields high shifting forces to overcome scale and debris, and it requires two control lines per HCM-Plus valve. A third port is included on the valve as part of the closed line circuit. This port reduces the number of lines required to operate a multizone system.

Hydraulic pressure applied from the surface shifts the HCM-Plus valve to the open or close position. If a hydraulic operation cannot be performed, the HCM-Plus valve has an integral shifting profile for mechanical operation.

The Baker Hughes testable control line jam nut fittings are some of the most widely used hydraulic connectors available in the market.

Applications

- Multiple zone production or injection wells requiring remote operations to isolate a specific zone when choking is not required

Benefits

- Intervention not required to open and close the valve
- Cost-effective, remote valve operation
- Reliable, simple design with proven technology and built-in flexibility

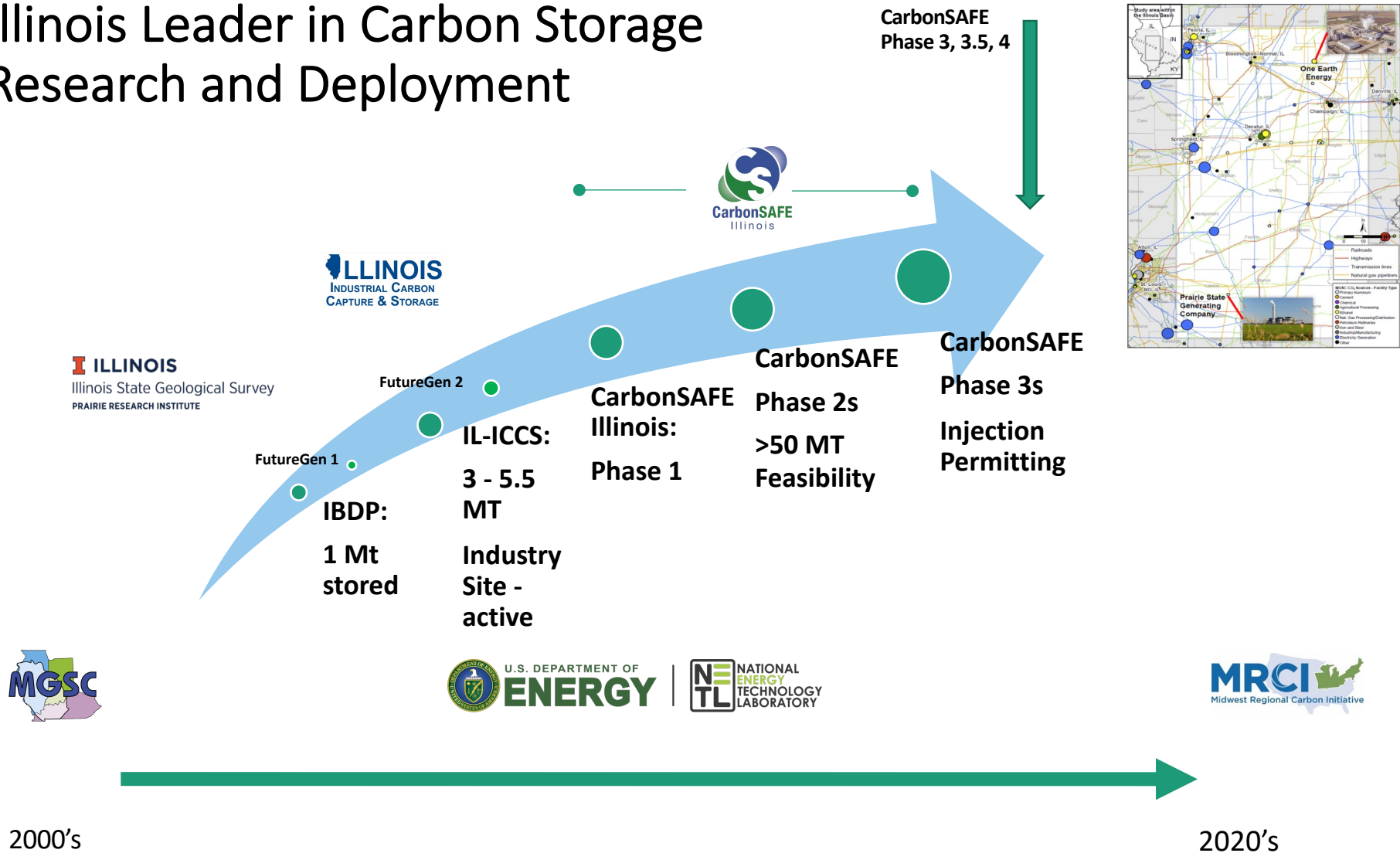
Features

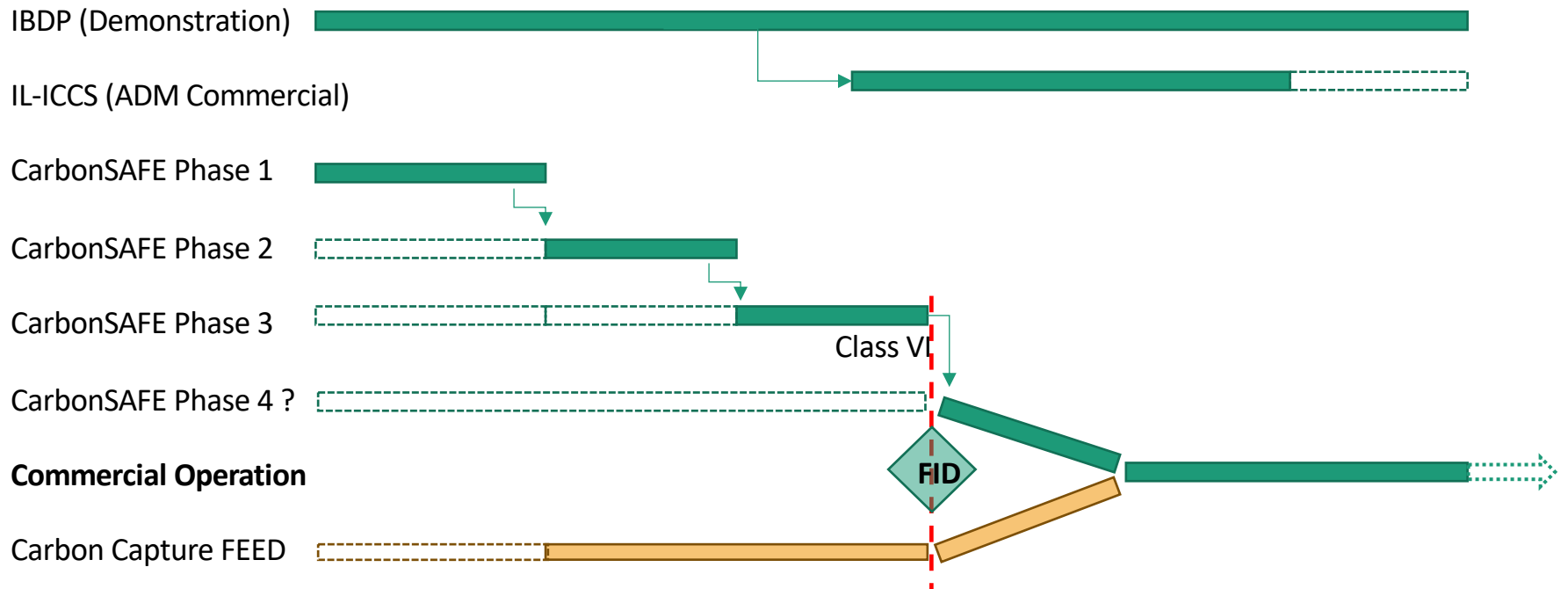
- Balanced piston design to open and close the valve at deep setting depths
- Simple surface procedures for valve actuation
- Non-elastomeric sealing technology isolated during flowing operations for high-performance sealing from tubing to annulus
- Testable control line jam nut fittings
- Control line bypass allows multiple valves, sensors, or chemical injection valves to be run as part of an intelligent well system
- Internal profiles allow placement of flow control devices
- Integral profile for secondary mechanical shifting
- Water- or oil-based control line fluid compatible

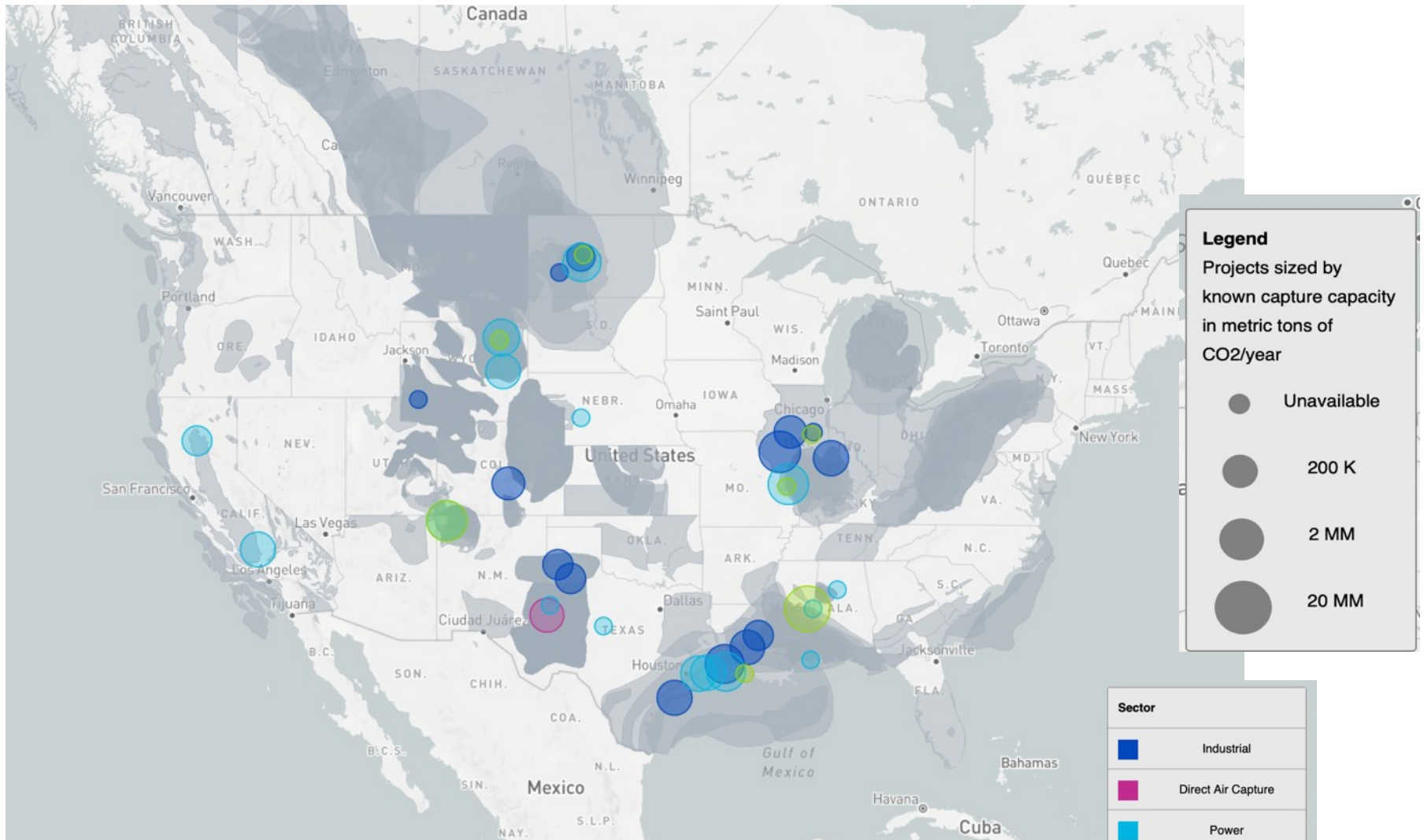
- Option 1 – Retain Westbay
- Option 2 – Schlumberger IntelliZone
- Option 3 – Baker Hughes Intelligent
- Option 4 – Drill new well

Two Fluid Sampling and Four Pressure Zones

Illinois Leader in Carbon Storage Research and Deployment

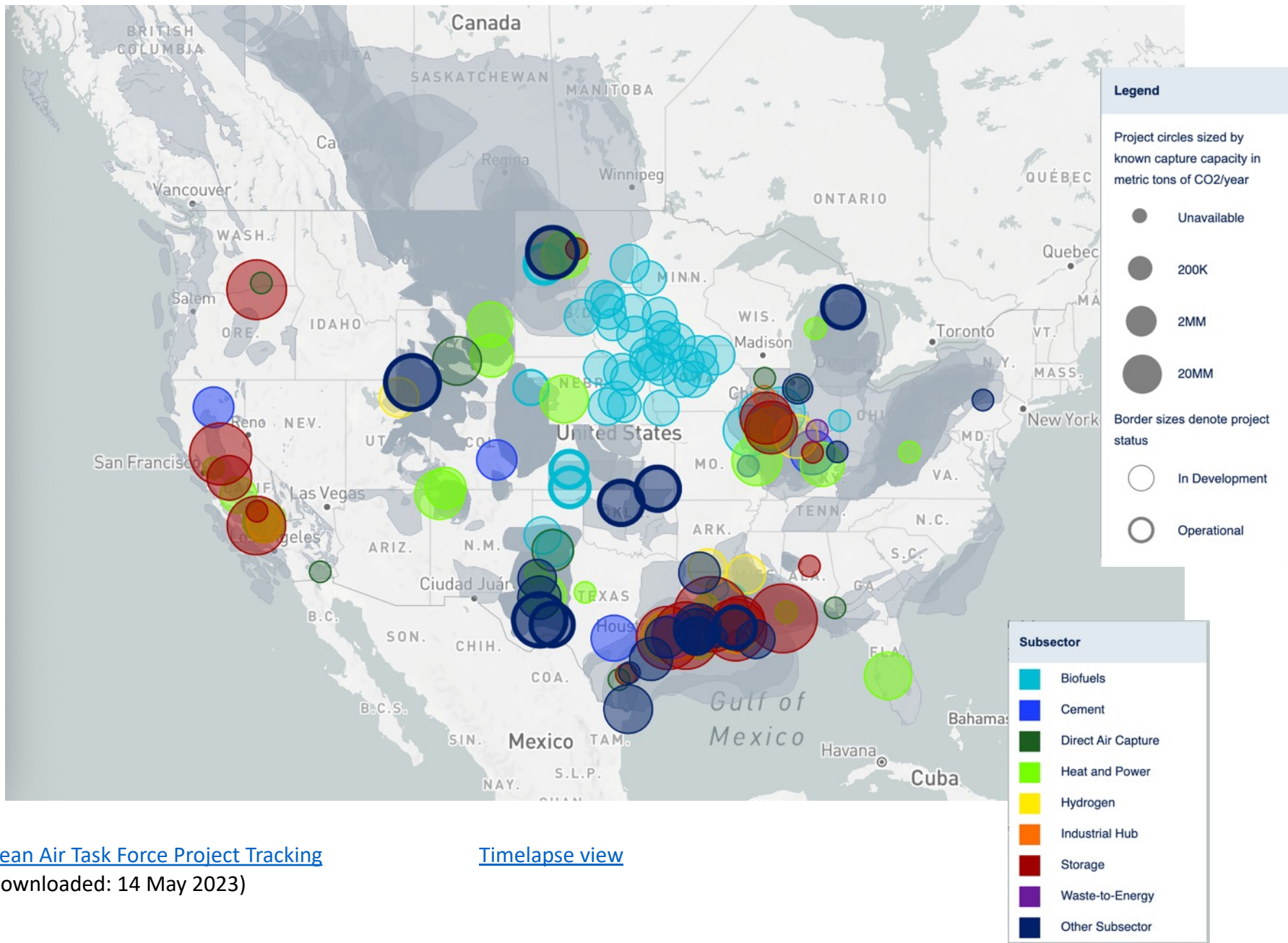






[Clean Air Task Force CCUS Interactive Map](#)

Downloaded: July 2020



[Clean Air Task Force Project Tracking](#)
(downloaded: 14 May 2023)

[Timelapse view](#)